An augmented reality navigation system for laparoscopic liver surgery – first experiences

Iwan Paolucci[1], Benjamin Eigl[1], Gian Andrea Prevost[2], Anja Lachenmayer[2], Matthias Peterhans[3], Daniel Candinas[2], Stefan Weber[1], Guido Beldi[2]

[1]ARTORG Center for Biomedical Engineering Research, University of Bern, Switzerland
[2]Department of Visceral Surgery and Medicine, Inselspital, Bern University Hospital, University of Bern, Switzerland
[3]CAScination AG, Bern, Switzerland

Introduction

Augmented reality (AR) is ubiquitous in education, production and ~~in industries like entertainment, but it~~ also has the potential to ~~emerge~~ drive~~into~~ ~~-~~medic~~ine~~al technology applications. ~~Especially~~ Specifically, ~~during~~in laparoscopic surgery, fusion~~ng~~ of various sources of virt~~vir-t~~ual or preoperative information with the live laparoscopic video could improve intraoperative visualization. In this study, we evaluated technical feasibility of an AR navigation system (CAS-One AR, CAScination AG, Switzerland) for laparoscopic liver surgery.

Methods

For navigation, a 3D laparoscope (Einstein Vision 3, Aesculap, Germany), a grasper and an overholt were equipped with optical markers and calibrated. Registration of the preoperative 3D model (Fraunhofer MeVis, Germany) was performed using four surface landmarks. After registration, an overlay of the underlying anatomy (tumors, liver segments, hepatic/portal vein and hepatic artery) and the tracked instruments was projected onto the liver on the 3D screen.

Results

To date, the system was applied in one patient with three lesions selected for non-anatomical resection. Time required for laparoscope and instrument calibration was 1:39 minutes. In total, four registration attempts were required with gradually decreasing registration errors from 22.9 mm to 6.1 mm and an average duration of 4 minutes each.

Conclusions

The AR system was mainly used during the initial phase of the surgery, where the 3D view of the underlying anatomy allowed fast localization of the tumors and was helpful for resection planning. We consider the additional time required for setup and registration to be acceptable for the first use in clinics. Based on our previous experience, we expect that the additional efforts and registration errors will decrease over time.